The robustness of the causal and economic relationship between construction flows and economic growth: evidence from Western Europe

Wilhelmsson, Mats; Wigren, Rune

THE ROBUSTNESS OF THE CAUSAL AND ECONOMIC RELATIONSHIP BETWEEN CONSTRUCTION FLOWS AND ECONOMIC GROWTH: EVIDENCE FROM WESTERN EUROPE

Journal:	*Applied Economics*
Manuscript ID:	APE-07-0217.R1
Journal Selection:	Applied Economics
Date Submitted by the Author:	04-Aug-2008
Complete List of Authors:	Wilhelmsson, Mats; Real Esatet and Construction, Real Estate Economics Wigren, Rune; Economics
JEL Code:	O47 - Measurement of Economic Growth|Aggregate Productivity < O4 - Economic Growth and Aggregate Productivity < O - Economic Development, Technological Change, and Growth
Keywords:	Construction, Economic Growth

THE ROBUSTNESS OF THE CAUSAL AND ECONOMIC RELATIONSHIP BETWEEN CONSTRUCTION FLOWS AND ECONOMIC GROWTH: EVIDENCE FROM WESTERN EUROPE

Abstract: Our main objective is to analyze whether we have a problem of parameter heterogeneity across countries and over time in the estimation of the relationship between infrastructure investments and economic growth. The research approach concerning causality and the estimating of the long run equilibrium is based on the error correction model. The problem of parameter heterogeneity is handled by the use of interaction terms. The result indicates that residential construction Granger causes GDP in the short and long run and it seems likely that the interaction term indicating high unemployment do add some explanation power to the model. This is not true when it comes to infrastructural and other building construction and its impact on economic growth. A high housing stock per capita seems to reduce the short run effect. That implies that residential construction seems to have a larger effect if the accumulated residential stock is on a low level. The speed of adjustment to long run equilibrium differs considerably between a country with a low residential capital stock and a country with a high capital stock. Moreover, high owner occupation rates seem to be associated with a stronger relationship between residential construction and economic growth.

Keyword: Construction, Economic Growth, Granger causality, Business cycles, Housing Policy

JEL Code: O47

1. Introduction

There is a belief among politicians and policy makers that public infrastructure investments and other construction enhance the economy of a country (see e.g. Turnovsky, 1997 and Delgado and Álvarez, 2007). This belief is also supported by a number of investigations and research done by such as e.g. Aschauer (1989), Green (1997), Coulson and Kim (2002) and Esafahani and Ramirez (2003). On the other hand, there have also been some indications that the causality between public investments and economic growth is not that straightforward as first expected, see e.g. Holtz-Eakin and Schwartz (1995) and Wigren and Wilhelmsson (2007a).

In the present paper, we analyze structural breaks over time, as causality and economic effects are not expected to be constant in boom and bust. The objective is also to examine whether the effects are a function of the accumulated capital stock, i.e. if the marginal effect is different depending on the level of the stock. We are also investigating if the housing policy in the country has any impact on the relationship between residential construction and economic growth. That is, our main objective is to analyze whether we have a problem of parameter heterogeneity across countries and over time. Our hypotheses are that construction investments have a stronger effect on economic growth in an economic bust; residential construction will have a larger impact on GDP growth if residential capital stock is low; and less state intervention is associated with a stronger impact on GDP from residential construction.

The rest of the paper is organized as follows. Section 2 presents a brief literature review. The methodology is presented in section 3. In section 4, we discuss the data and the empirical model. Section 5 and 6 presents the results concerning the level of the residential capital stock and choice of housing policy, respectively. Section 7 concludes and summarizes the paper.

2. A Brief Literature Review

A huge literature analyzing economic growth and its determinants exist[1]. Lately, many of them are based on endogenous growth model theory (see e.g. Romer, 1986 and Temple, 1999). At the end of 1980 and early 1990, a number of studies presented a strong and positive relationship between public infrastructure and economic productivity in the private sector (see e.g. Aschauer, 1989, and Munnell, 1990). Furthermore, results indicate that the construction industry generates one of the highest multiplier effects with other sectors of the economy, Park (1989). Recently, Shioji (2001) find that infrastructure capital has a significant positive, but modest effect on economic growth using a panel data set of United States and Japanese regions.

The result by Aschauer and Munnell were e.g. criticized by Holtz-Eakin (1994). The main objection he raises is that earlier studies did not correctly account for fixed effects. To be able to correctly estimate the short and long run effect of construction on economic growth one need to remove country

[1] A complete literature review can be found in Gramlich (1994), Temple (1999) and Jiang (2001).

fixed effects, see e.g. Temple (1999) and Shioji (2001). With a neoclassical growth model with fixed or random effects Holtz-Eakin and Schwartz (1995) repeated the above analysis by Aschauer (1989) and found no or only marginal impact of infrastructure investments on growth. Nijkamp and Poot (2004) found "evidence for a positive effect of conventional fiscal policy on growth is rather weak".

Causality

Using U.S. data for the period 1959 to 1992, Green (1997) found that residential investment Granger causes GDP, while non-residential investment is Granger caused by GDP. However, the opposite is not true. Green also tested for the existence of structural breaks in the causality relationship and found such ones. Later, Coulson and Kim (2002) confirm the result by Green (1997). Wigren and Wilhelmsson (2007a) examined the statistical relationship between gross domestic product and a broad group of construction in Western Europe from 1980 to 2004. The overall conclusion was that public infrastructure policies have an effect on short-run economic growth but only a weak effect on the long run. Lean (2001) empirically tests the linkage between construction and other economic sectors in Singapore. In the paper, an econometric procedure is proposed that can be used for determining the construction linkage to economic growth and involves unit-root testing and Granger causality. The study shows the causal relationships between construction and GDP is two-way.

Parameter heterogeneity

Gauger and Snyder (2003) investigate if the financial deregulation has changed the relationship between residential construction and key macroeconomic variables. The overall results indicate that residential construction shocks have increased the prediction power concerning changes in GDP under a more deregulated regime. Hence, less state intervention on the housing market may increase the impact of construction on growth. This is in accordance with e.g. Smith (1997) arguments that housing policies have an effect on residential constructions. The argument for that is that countries differing widely in housing policy are unlikely to fulfill the statistically modeling assumption about parameter constancy (Temple, 1998 and 1999) even if non-linearity may explain some of the parameter heterogeneity (Masanjala and Papageorgiou, 2004). In this paper, parameter heterogeneity is analyzed by introducing a set of interaction variables concerning the degree of state intervention on the housing market suggested by Temple (1999).

Odedokun (1996) investigated the relationship between the financial sector and economic growth in 71 countries. The conclusion drawn in the paper is that the financial sector promotes economic growth, but this impact is stronger in low income than in high-income countries. Hence, it indicates that changes in construction may have a larger impact on economic growth if the public capital stock is low compared to high one. Furthermore, Smith (1997) argues that the size of the housing stock influence the residential construction. Here, the problem with parameter heterogeneity between countries with high capital stock compared to low areas will be handled in the same manner as housing policy, i.e., with a set of interaction variables.

It is not only parameter heterogeneity across countries that could be a problem. It is not likely that the parameters are constant over time. The argument for that is that when there are idle resources in the economy, construction would have a larger impact on GDP compared to a situation when all resources are used. That is, in a business cycle boom there is a risk that construction will crowd-out other types of investments with higher productivity and thereby decreasing the economic growth. In an attempt to control for parameter heterogeneity over time and eliminate business cycle effects, we introduce a set of interaction terms relating construction with unemployment rates.

3. Methodology

We investigate the relationship between construction and economic activity using a simple stylized model. That is, we merely relate change in production to exogenous changes in the construction, measured by investments in residential building, other construction, and investments in infrastructure. The basic model is derived from a production function model where we have added public capital stock (buildings and infrastructure) to labor and stock of private capital. There are some potential econometric problems in the estimating of the production function such as non-stationarity, causality, and omitted variables, see e.g. discussion in Gramlish (1994) and Holtz-Eakin (1994), as well as Temple (1999) and Gobbin and Rayp (2008). We have addressed these problems by using a pooled cross-sectional and time series data, allowing us to use fixed effects, and estimated the model in an error-correction framework. The problem of parameter heterogeneity is handled by the use of interaction terms (see Temple, 1999).

The research approach concerning causality and estimating the long run equilibrium is based on Engle and Grangers (1987) error correction model (see e.g. Ramajo, J. 2001). If two variables y and x are both integrated of order 1, I(1), and if a linear combination between them exists that yields a stationary variable, y and x are said to be co-integrated. If we assume y to be a function of x in a simple linear regression framework, we can write the following equation:

$$y_{i,t} = bx_{,it} + e_{i,t} \qquad (1)$$

where both y and x are I(1), and e is I(0), subscript *i* indicate country and *t* years. Following Banerjee et al (1993), a general dynamic regression model in the form of error correction model (ECM) is equal to:

$$\Delta y_{i,t-1} = \alpha_i + \lambda e_{i,t-1} + \sum_{j=1} \beta_1(j)\Delta y_{i,t-j} + \sum_{j=0} \beta_2(j)\Delta x_{i,t-j} + \varepsilon_{i,t} \qquad (2)$$

where *y* is equal to the dependent variable and *x* the independent. α is equal to fixed country effects. Subscript *i* is equal to country and *t* is equal to year. Index *j* is equal to number of lag. $e_{i,t-1}$ is equal to

($y_{i,t-1}$-$\beta x_{i,t-1}$) in equation 1 above, that is, the ECT. By using the error-correction framework, it is possible to capture the adjustment in economic growth, by not only the changes in construction and fixed effects but also by how much GDP deviates from the long run equilibrium.

If β_2 are jointly significantly different from zero, x Granger causes y in the short run. The long-run Granger causality can be found by testing the significance of the ECT. As we are using panel data, a fixed effect model will be used to account for idiosyncratic country effects. Among other things, the fixed effects controls for initial endowment that is constant over time. To control for business cycles, capital accumulation and housing policy, β_2 and λ will be estimated separately in boom and bust and with high or low capital accumulation or depending on the housing policy in the country (Equation 3).

$$\begin{aligned}
\Delta y_{i,t-1} &= \alpha_i + \lambda_1 e_{i,t-1} + \lambda_2 D_{i,t} e_{i,t-1} + \lambda_3 C_{i,t} e_{i,t-1} + \lambda_4 F_{i,t} e_{i,t-1} + \\
&\sum_{j=1} \beta_1(j)\Delta y_{i,t-j} + \sum_{j=0} \beta_2(j)\Delta x_{i,t-j} + D_{i,t} \sum_{j=0} \beta_3(j)\Delta x_{i,t-1} + \\
&C_{i,t} \sum_{j=0} \beta_4(j)\Delta x_{i,t-2} + F_{i,t} \sum_{j=0} \beta_5(j)\Delta x_{i,t-2} + \varepsilon_{i,t}
\end{aligned} \tag{3}$$

where D is a binary variable indicating if unemployment is high in the country, C is a binary variable indicating whether the country has low housing capital accumulation in the beginning of the period and F depending on the housing policy (less state intervention) in the country. If β_2 are jointly significantly different from zero, x Granger causes y in the short run. If β_3 are jointly negatively significantly different from zero, x Granger causes y in the short run to a higher degree if unemployment is high. Furthermore, if β_4 are jointly significantly different from zero, x Granger causes y in the short run to a higher degree if the country has a low residential capital stock in the beginning of the period. Finally, if β_5 are jointly significantly different from zero, x Granger causes y in the short run to a higher degree if the country has a less state intervention as a housing policy.

4. The Data

The data[2] consist of information about total construction. As it is potentially important to be able to disaggregate construction as different types of constructions have different effects on GDP, see e.g. the results by Shioji (2001), we are using disaggregated data concerning of residential construction (variable name: Resi); other construction (Build) and infrastructure construction (Infra). All the variables are measured in million USD in 1999 years prices and come from Euroconstruct. The data are supplemented with data on GDP in billion USD and in 2000 years prices from OECD and Euroconstruct. The cross section is 14 European countries. The period under studied is 1980-2004. As we are using a panel data set, it is possible to avoid the endogeneity problem by using lags as instruments (Temple, 1999). Another advantages using panel data set is that it allows us to control for

[2] The data comes from reports from Euroconstruct conferences 1990-2004 (two each year, different places of publication) and a compilation from Euroconstruct conferences 1980-1995 made by Hans Georg Graf, SGZZ, St Galler Zentrum für Zukunftsforschung.

omitted variables that are constant over time (the fixed effects) and that we have more degrees of freedom (see Baltagi, 1995 and Temple, 1999).

Data concerning business cycles is measured by using unemployment rates to define periods where unemployment is very high or low (variable names HUE and LUE). Accumulated residential stock is measured by using housing stock per capita (HS). It is a dummy variable where one represents if the country has a housing stock per capita above or equal to median housing stock per capita among the investigated countries. Housing policy is measured by looking at private rented sector, social-rented sector and owner occupation. The definition is based on Balchin (1996). Two dummy variables are included in the residential model. The first measure represents if the country has a private rented sector above the EU average (PR) and the second measure if the country has an owner-occupation above the EU average (OW). That is, the default indicates if the country has a social-rented sector above or broadly at the EU average.

4.1. Pre-test of the data

Our central interest is to test the data concerning stationarity as this indicates that there is a long run relationship between construction and economic growth. Stationarity is defined as a variable where the mean, variance, and autocovariance are constant over time. A stationary variable is integrated of order zero and a variable that must be differentiated once to become stationary is said to be integrated of order one (see Granger et al, 2001).

An augmented Dickey-Fuller test for a unit root has been utilized, but we have used the Levin and Lin-test (LL) version of the test (see Levin et al, 2002). The tested model is given by:

$$\Delta Y_{i,t} = \mu_i + \beta Y_{i,t-1} + \phi \Delta Y_{i,t-1} + \gamma_t + \varepsilon_{i,t} \qquad i\text{=1-14; } t\text{=1980-2004} \qquad (4)$$

The test implicitly assumes that all countries series have a common autoregressive coefficient. The data are said to follow a unit root if β is not significantly different from zero. As Levin and Lin have showed, the parametric test statistics converges to a standard normal distribution under certain condition. We have used the critical values provided by Levin and Lin in their first version of the paper (1992). The critical value concerning the t-statistics (LL-test) without time trends is –2.00. We do relax the strong assumption about homogeneity in Levin and Lin's test by also utilizing the Im, Pesaran and Shin's (2003) test (IPS)[3]. The test is parametric and critical values are presented in their paper. The 5% critical value is equal to -1.83 with the use of 25 periods and 14 cross-sections with no time trends. See Harter-Dreiman (2004) and Alba and Papell (2007) for an empirical use of the IPS-test and LL-test.

Table 1 in here

[3] See also Jönsson (2006).

The unit root tests (without a time trend) for the panel indicate that a unit root is rejected for all the variables except GDP. However, when the individual countries are analyzed, most of the series are integrated of order 1.

4.2. Causality and Economic Effects

To proceed with the test concerning Granger causality, we test the error correction term (ECT) considering unit root. In the next stage, we estimate equation 3 with all the variables as dependent variables, respectively. The estimations will be carried out on the panel data with fix country effects. Due to lack of data, we are only testing when *j=2*. The Granger causality test implies that the error-correction term is integrated of order zero, that is, the error term is stationary. The ADF-tests concerning the ECT in the panel set are all stationary, except the ECT concerning GDP regressed on investments (residential, buildings and infrastructure).

In table 2-5 below, the parameters in equation 3 are presented. In the first results is the dependent variable is equal to the change in GDP and the independent variables are lagged changes in GDP (Dgdp), lagged changes in residential construction (Dresi) and the error correction term (e). Some models also include dummy variables indicating high and low unemployment (HUE and LUE). F-tests are used to find out whether there is any improvement going from model A3 to A4 or from Model A4 to A5. A high F-value indicates that the parameters of the change in residential construction multiplied by the dummy representing high unemployment (Dresi*HUE(t) etc) are jointly significantly different from zero.

The result suggests that residential construction Granger causes GDP in the short and long run (high F-values). It seems likely that the interaction variable adds some explanation power to the model, i.e., if unemployment is high, residential construction has a higher impact on economic growth. However, none of the individual parameters is significantly different from zero. Surprisingly, the results also indicate that construction in low unemployment periods have a higher positive effect on economic growth. If residential construction increases by 1 percent, GDP will increase by 0.02 percent the following years. In periods with high unemployment, the effect is about 0.07 percent and in periods with low unemployment, the effect is as high as 0.15 percent. The speed of adjustment to long run equilibrium is about 10-11 years, that is, if expected GDP is higher compared to actual GDP, the change in GDP is expected to be positive and the adjustment will be a tenth of the gap per year. The Granger causality is not conclusive. Residential construction Granger causes GDP both in short and long term. If expected residential construction is lower than the actual residential construction, the speed of adjustment to long run equilibrium is about 5 years.

Table 2 in here

The relationship between other building construction and economic growth is presented in table 3 below. The model can explain almost 44 percent of the variation in changes of GDP. Concerning construction of other building, such as office building, Granger causes GDP in both short and long run. The model is not improved by including the interaction variables. That is, the results indicate that the parameters are constant over the business cycle.

Table 3 in here

If construction of other building increases by 1 percent, GDP is expected to increase by 0.03 percent the following years. The speed of adjustment to long run equilibrium is about 10 years. However, the Granger causality is not conclusive. Construction Granger causes GDP but GDP also Granger causes construction of other buildings. If expected level of other building construction is higher than the actual building activity, the speed of adjustment to long run equilibrium will be around 7 years. The relationship between infrastructure construction and economic growth is presented in table 4 below.

Table 4 in here

The model can explain approximately 37 percent of the variation in GDP. Construction in infrastructure Granger causes GDP both in short and long term. The model is not improved if the interaction variables are included in the model. The results indicate that investments in infrastructure do not have a larger impact on GDP growth if the unemployment is high and low. If infrastructure construction increases by 1 percent, GDP is expected to grow by 0.02 percent. The speed of adjustment to long run equilibrium is about 12 years. The Granger causality is not conclusive. Construction Granger causes GDP but GDP also Granger causes construction of other buildings.

5. Residential Stock

Additional residential construction in a country where the housing stock is already high compared to the population could affect the short and long run relationship between economic growth and residential construction. Our hypothesis is that high accumulation of residential stock should have a negative effect on residential construction effects on the change in GDP.

As a measure of the accumulation of residential stock in a country, we are using housing stock per capita. If the housing stock per capita is equal or above the median housing stock per capita in the investigated countries, we interpret it as high accumulation of residential capital. To be able to investigate its impact on the short and long run effect, we interacts the dummy variable with the change in residential construction (lagged 0 to 2 years) and the error correction term. The results are presented in the table 6 below (Model A6). The main results indicate that the models explanation power increases. As before, residential construction has a short run and long run effect on GDP. If residential construction increases by 1 percent, we expect that GDP will change with around 0.05 percent. However, we expect also that the effect will be higher if the unemployment is high (around 0.1 percent). Unexpectedly, the effect in short run seems to be even higher if the unemployment is very low (up to 0.17 percent). The latter is probably a demand driven effect and the former a supply driven effect.

A high housing stock per capita seems to reduce the short run effect. That is, residential construction seems to have a large effect if the accumulated residential stock is on a low level. The speed to adjustment to long run equilibrium differs considerably between a country with a low residential capital stock and a country with a high. The results indicate that the speed to adjustment is approximately 5 years if the capital stock is low. On the other hand, if the capital stock is already high, it will take some considerably time to adjust long to run equilibrium (50 years). This effect is highly significant.

6. Housing Policy

In general, housing policy reflects the political ideology of the government in power (see Balchin, 1996). Here we will categorize the countries in Europe into three broad groups based on only a few aspects of housing policy, namely (1) support to social-rented sector, (2) promote owner-occupation and (3) promote private landlordism. Countries in the first group are the Netherlands, Austria, Sweden, Denmark and France. The second group consists of Switzerland, Germany and Belgium. Finally, in the third group we find countries such as Spain, Finland, Italy, UK, Portugal and Norway. Our hypothesis is that the short run effect will be lower in countries with more state intervention and that the speed of adjustment in countries with a high social-rented sector will be lower compared to in countries where the housing policy are focused to less state intervention. The results are shown in the table below (Model A7).

Table 5 in here

The conclusions are that by introducing variables indicating choice of housing policy, we explain more that 50 percent of the variation in GDP. However, the results are more or less the same, but accumulated residential stock seems to be of less importance if we add variables indicating choice of housing policy. However, housing policy and housing stock is not correlated so there is not a problem of multicollinearity. On the other hand, housing policy seems to have a major effect on the relationship between residential construction and GDP. For example, residential construction in countries with housing policy characterized by a private rented sector above EU average or owner-occupation above the EU average have a larger effect on GDP compared to countries with a social-rented sector above or broadly at the EU average. However, the housing policy does not have any impact on the speed of adjustment to long run equilibrium. Even if there is little statistical evidence to support the view that owner occupation is associated with high income per capita (see e.g. Balchin, 1996), high owner occupation rates seem to be associated with a stronger relationship between residential construction and economic growth. If residential construction increases by 1 percent, the expected effect on GDP growth is 0.04 percent if the owner occupation rate is low and 0.08 percent if the owner occupation rate is high. This result is highly statistically significant.

7. Conclusion and Policy Implications

The research task in the present study is to analyze the statistical causality relationship and parameter heterogeneity between gross domestic product and a broad group of construction in Western Europe.

The long run Granger causality tests are in most cases inconclusive, that is, the Granger causality goes in both directions. Our results are in accordance with e.g. Wang (2002) and Lean (2001) whose result shows that both public infrastructure and economic growth have significant effects on each other. On the other hand, Tse and Ganesan (1997) results suggest that construction Granger Cause GDP but not wise versa in Hong Kong.

Furthermore, if we examine the individual parameters concerning the error correction term, it could be concluded that they are of small magnitude, indicating slow adjustment to long run equilibrium. Our results are in accordance with e.g. Green (1997) and recently Coulson and Kim (2002), whose result shows that the impact of residential investments on GDP is more evident than non-residential investments.

The long run Granger causality between the different types of construction goes in both directions. For example, residential constructions Granger cause public infrastructure investments in the long run, and vice versa. The model concerning residential construction and economic growth indicate that residential constructions short run effect are higher if we have a high unemployment, but it is also true that its effect is higher when we have a low unemployment. Supply-side variables probably drive the former relationship and the latter by demand-side variables. Furthermore, high residential capital stock seems to reduce the impact of residential construction on GDP growth. The results also indicate that countries with a housing policy with less state intervention have a stronger effect from residential construction on economic growth.

Construction of other building and infrastructure investments has a positive effect on economic growth both in short and long term. The policy implication from our results indicates that residential construction can have a substantial effect on economic growth in countries with e.g. high unemployment, less state intervention on the housing market and a low stock of housing per capita. An increase in construction by 1 % can effect GDP growth by as much as 0.15 %. On the other hand, residential construction will have very small or no effect on economic growth if the housing stock per capita is already high or if the housing market is state intervened (e.g. large social housing sector).

References

Alba, J. and Papell, D. (2007). Purchasing Power Parity and Country Characteristics: Evidence from panel data tests. *Journal of Development Economics*, 83, 240-251.

Ashauer, D., Alan (1989). Is public investment productive? *Journal of Monetary Economics*. 23, 177-200.

Balchin, P. (1996). *Housing Policy in Europe*. Routledge, London and New York.

Baltagi, B. H. (1995). *Econometric Analysis of Panel Data*.John Wiley & Sons, West Sussex, England.

Banerjee, A., Dolado, J. J., Galbraith, J. W. and Hendry, D. F. (1993). *Co-Integration, Error-correction, and the Econometric Analysis of Non-Stationary Data*. Oxford University Press Inc., New York.

Button, K. (1998). Infrastructure investment, endogenous growth and economic convergence. *The Annals of Regional Science*. 32, 145-162.

Coulson, E. and Kim, M-S. (2002). Residential Investment, Non-residential Investment and GDP. *Real Estate Economics*, 28(2), 233-248.

Delgado, M. J. and Álvarez, I. (2007). Network infrastructure spillover in private productive sectors: evidence from Spanish high capacity roads. *Applied Economics*, 39(12), 1583 - 1597

Engle, R. F. and Granger, C.W.J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55(2), 251-276.

Esafahni, H.S. and Ramirez, M.T. (2003). Institutions, infrastructure, and Economic Growth. *Journal of Development Economics*, 70, 443-477.

Gauer, J. and Snyder, T. C. (2003). Residential Fixed Investment and the Macroeconomy: Has Deregulation Altered Key Relationships? *Journal of Real Estate Finance and Economics*. 27(3), 335-354.

Gobbin, N. and Rayp, G. (2008). Different ways of looking at old issues: a time-series approach to inequality and growth. *Applied Economics*, 40(7), 885 – 895.

Gramlich, E., M. (1994). Infrastructure Investment: A Review Essay. *Journal of Economic Literature*. 32, 1176-1196.

Granger, C.W.J., Hyung, N., and Jeon, Y. (2001). Spurious regressions with stationary series. *Applied Economics*, 33(7), 899 – 904.

Green, R. (1997). Follow the Leader: How Changes in Residential and Non-residential Investment Predict Changes in GDP. *Real Estate Economics*, Vol.25, 253-270.

Harter-Dreiman, M. (2004). Drawing Inferences about housing supply elasticity from house price responses to income shocks. *Journal of Urban Economics*, 55, 316-337.

Holtz-Eakin, D. (1994). Public-Sector Capital and the Productivity Puzzle. *The Review of Economic and Statistics*. 70(1), 12-21.

Holtz-Eakin, D. and Schwartz, A. E. (1995). Infrastructure in a Structural model of economic growth. *Regional Science and Urban Economics*. 25, page 131-151.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels. *Journal of Econometrics*. 115, 53-74.

Jiang, B. (2001). *A Review of Studies on the Relationship between Transport Infrastructure Investments and Economic Growth*. Canada Transportation Act Review. Vancouver, British Columbia.

Jönsson, K. (2006). Time-specific disturbances and cross-sectional dependency in a small-sample heterogeneous panel data unit root test. *Applied Economics*, 38(11), 1309 – 1317.

Lean, C. S. (2001). Empirical tests to discern linkages between construction and other economics sectors in Singapore. *Construction Management and Economics*. 19, 355-363.

Levin, A., Lin, C. and Chu, J. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties. *Journal of Econometrics*. 108, 1-24.

Masanjala, W. and Papageorgiou C. (2004). The Solow Model with CES Technology: Nonlinearities and Parameter Heterogeneity. Journal of Applied Econometrics, 19, 171-201.

Munnell, A., H. (1990). Why has productivity growth declined? Productivity and public investment. *New England Economic Review*. Page 3-22.

Nijkamp, P. and Poot, J. (2004). Meta-analysis of the effect of fiscal policies on long-run growth. *European Journal of Political Economy*. 20, 91-124.

Odedokun, M.O. (1996). Alternative Econometric Approaches Analysing the Role of the Financial sector in Economic Growth: Time-Series evidence from LDCs. *Journal of Development Economics*, 50(1), 119-46.

Park, S.H. (1989). Linkages between industry and services and their implications for urban employment generation in developing countries. *Journal of Development Economics*, 30(2), 359-79.

Ramajo, J. (2001). Time-varying parameter error correction models: the demand for money in Venezuela, 1983.I-1994.IV, *Applied Economics*,33(6), 771 – 782.

Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy*. 94, 1002-1037.

Shioji, E. (2001). Public Capital and Economic Growth: A Convergence Approach. *Journal of Economic Growth*, 6, 205-227.

Smith, J.E. (1997). *What Determines Housing Investment?* Housing and Urban Policy Studies 12. Delft University Press. ISBN 90-407-1420-7

Temple, J. (1998). Robustness tests of the augmented Solow model. *Journal of Applied Econometrics*, 13, 361-375.

Temple, J. (1999). The New Growth Evidence. *Journal of Economic Literature*, March, 112-156.

Tse, R.Y.C. and Ganesan, S. (1997). Causal relationship between construction flows and GDP: evidence from Hong Kong. *Construction Management and Economics*, 15, 371-376.

Turnovsky, S. (1997). Fiscal Policy in a Growing Economy with Public Capital. *Macoeconomic Dynamics*, 1, 615-639.

Wang, E. C. (2002). Public infrastructure and economic growth: a new approach applied to East Asian economies. *Journal of Policy Modeling*. 24, 411-435.

Wigren, R. and Wilhelmsson, M. (2007a). Construction Investments, Crowding-Out/Filling-In and Economic Growth in West-Europe. *Journal of Policy Modeling*. 29(3), 429-451.

Wigren, R. and Wilhelmsson, M. (2007b). Housing Stock and Price Adjustments in 12 West-European Countries between 1976 and 1999. *Housing, Theory and Society*. 24(2), 133-154.

Table 1. Unit Root Test (t-statistics)

	GDP		Total		Residential		Buildings		Infrastructure	
	Level	Diff.	Level	Diff.	Level	Diff.	Level	Diff.	Level	Diff.
LL-test	-2.5		-3.8		-3.7		-3.7		-3.8	
IPS-test	-0.4	-3.1	-2.0	-2.8	-2.2	-2.7	-2.0	-2.9	-1.3	-3.2
Austria	0.0	-3.7	-0.7	-4.1	-2.2	-2.5	-0.8	-3.9	0.9	-4.8
Belgium	0.3	-2.6	-1.5	-2.3	-1.4	-2.8	-1.8	-2.9	-1.3	-2.3
Denmark	-0.5	-2.6	-2.0	-3.4	-1.6	-3.3	-2.2	-3.2	-1.7	-5.1
Finland	-0.3	-2.8	-3.1	-3.1	-2.5	3.1	-2.9	-2.6	-2.6	-4.1
France	0.0	-2.6	-4.0	-3.1	-3.2	-3.3	-4.1	-3.4	-1.9	-2.3
Germany	-0.8	-3.3	-1.5	-2.1	-1.9	-2.5	-0.5	-1.6	-1.6	-2.6
Italy	-0.9	-2.9	-1.8	-2.9	-2.6	-2.5	-2.1	-2.8	0.0	-2.4
Netherlands	-0.7	-3.9	-2.0	-3.2	-1.4	-4.2	-3.2	-1.9	-1.5	-3.2
Norway	-0.2	-3.3	-2.3	-2.6	-1.8	-2.6	-2.7	-2.8	-1.9	-4.0
Portugal	-0.9	-2.8	-1.6	-2.1	-2.6	-2.3	-0.9	-4.8	-0.7	-2.0
Switzerland	0.1	-2.6	-0.6	-2.9	-0.3	-2.5	-1.0	-2.7	-1.2	-3.5
Spain	0.1	-3.3	-3.1	-2.8	-3.2	-2.6	-2.8	-3.3	-1.0	-4.1
Sweden	-0.8	-3.0	-1.2	-2.2	-3.7	-4.8	-1.7	-1.8	-1.5	-2.5
UK	-0.3	-3.4	-3.2	-2.2	-3.0	-4.8	-1.5	-2.7	-1.5	-2.4

Table 2. Economic Growth and Residential Construction.
(Dependent variable=Dgdp)

	Model A1	Model A2	Model A3	Model A4	Model A5
Dgdp(t-1)	0.6220	0.5938	0.5970	0.5359	0.5343
	(11.16)	(10.63)	(10.93)	(9.60)	(9.54)
Dgdp(t-2)	-0.2025	-0.2608	-0.1968	-0.1757	-0.1788
	(-3.56)	(-4.60)	(-3.40)	(-3.02)	(-3.06)
Dresi(t)	-	0.0589	0.0644	0.0534	0.0526
		(7.31)	(8.04)	(5.80)	(5.66)
Dresi(t-1)	-	-0.0307	-0.030	-0.0371	-0.0373
		(-3.20)	(-3.23)	(-3.60)	(-3.59)
Dresi(t-2)	-	0.021	0.0082	0.0046	0.0044
		(1.45)	(0.99)	(0.50)	(0.48)
Dresi*HUE(t)	-	-	-	0.0218	0.0238
				(1.43)	(1.54)
Dresi*HUE(t-1)	-	-	-	0.0281	0.0297
				(1.82)	(1.91)
Dresi*HUE(t-2)	-	-	-	0.0139	0.0150
				(0.91)	(0.98)
Dresi*LUE(t)	-	-	-	0.1043	0.1042
				(3.52)	(3.51)
Dresi*LUE(t-1)	-	-	-	0.0278	0.0291
				(0.89)	(0.92)
Dresi*LUE(t-2)	-	-	-	0.0124	0.0122
				(0.37)	(0.35)
e(t-1)	-0.0599	-	-0.1013	-0.0993	-0.0824
	(-2.10)		(-3.80)	(-3.81)	(-2.58)
e*HUE (t-1)				-	-0.0613
					(-0.91)
e*LUE (t-1)				-	-0.0253
					(-0.30)
Constant	0.0129	0.0145	0.0130	0.0136	0.0137
	(8.70)	(10.07)	(8.91)	(9.04)	(9.04)
R^2	0.3069	0.4063	0.4346	0.4745	0.4762
n	308	308	308	308	308
k	3	5	6	12	14
F-value:					
A4 vs A3	-	-	-	3.73	-
A5 vs A4	-	-	-	-	0.48
F-value:					
Short run effect	-	-	22.66	10.45	8.61
Long run effect	-	-	15.07	5.47	4.34

Note: t-value within parenthesis. Parameters concerning fixed effects are not shown in the table, but available upon request. All short run effects are compared to model A1 and all long run effects are compared to model A2.

Table 3. Economic Growth and Other Construction.
(Dependent variable=Dgdp)

	Model B1	Model B2	Model B3	Model B4	Model B5
Dgdp(t-1)	0.6268	0.4218	0.4309	0.4007	0.4041
	(11.23)	(6.88)	(7.16)	(6.43)	(6.45)
Dgdp(t-2)	-0.2048	-0.1984	-0.1495	-0.1173	-0.1127
	(-3.64)	(-3.19)	(-2.39)	(-1.81)	(-1.71)
Dbuild(t)	-	0.0692	0.0737	0.0677	0.0673
		(6.54)	(7.05)	(5.54)	(5.48)
Dbuild(t-1)	-	-0.0081	-0.0106	-0.0193	-0.0202
		(-0.73)	(-0.97)	(-1.53)	(-1.59)
Dbuild(t-2)	-	-0.0156	-0.0172	-0.0205	-0.0214
		(-1.57)	(-1.76)	(-1.83)	(-1.90)
Dbuild*HUE(t)	-	-	-	0.0094	0.0111
				(0.46)	(0.53)
Dbuild*HUE(t-1)	-	-	-	0.0292	0.0298
				(1.44)	(1.47)
Dbuild*HUE(t-2)	-	-	-	0.0110	0.0127
				(0.57)	(1.47)
Dbuild*LUE(t)				0.0539	0.0537
				(1.63)	(1.62)
Dbuild*LUE(t-1)				0.0125	0.0177
				(0.37)	(0.51)
Dbuild*LUE(t-2)				-0.0167	-0.0180
				(-0.44)	(0.47)
e(t-1)	-0.0697	-	-0.099	-0.0974	-0.0833
	(-2.29)		(-3.50)	(-3.44)	(-2.42)
e*HUE(t-1)	-	-	-	-	-0.0368
					(-0.48)
e*LUE(t-1)					-0.0655
					(-0.71)
Constant	0.0128	0.0166	0.0153	0.0150	0.01474
	(8.69)	(10.15)	(9.34)	(8.52)	(8.21)
R^2	0.3088	0.3965	0.4211	0.4349	0.4363
N	308	308	308	308	308
K	3	5	6	12	14
F-value:					
B4 vs B3	-	-	-	1.20	-
B5 vs B4	-	-	-	-	0.36
F-value:					
Short run effect	-	-	19.46	7.31	6.02
Long run effect	-	-	12.79	2.86	2.30

Note: t-value within parenthesis. Parameters concerning fixed effects are not shown in the table, but available upon request. All short run effects are compared to model B1 and all long run effects are compared to model B2.

Table 4. Economic Growth and Infrastructural Construction.
(Dependent variable=Dgdp)

	Model C1	Model C2	Model C3	Model C4	Model C5
Dgdp(t-1)	0.6150	0.6030	0.6034	0.6039	0.6021
	(11.18)	(10.58)	(10.77)	(10.57)	(10.50)
Dgdp(t-2)	-0.1824	-0.2259	-0.1741	-0.1674	-0.1728
	(-3.23)	(-3.94)	(-2.98)	(-2.82)	(-2.89)
Dinfra(t)	-	0.0413	0.0416	0.0381	0.0381
		(3.63)	(3.72)	(2.88)	(2.87)
Dinfra(t-1)	-	-0.0277	-0.0272	-0.0314	-0.0311
		(-2.57)	(-2.57)	(-2.50)	(-2.47)
Dinfra(t-2)	-	-0.0048	-0.0054	0.0047	0.0049
		(-0.45)	(-0.52)	(0.39)	(0.41)
Dinfra*HUE(t)	-	-	-	0.0321	0.0327
				(1.24)	(1.26)
Dinfra*HUE(t-1)	-	-	-	0.0048	0.0048
				(0.19)	(0.19)
Dinfra*HUE(t-2)	-	-	-	-0.0348	-0.0346
				(-1.38)	(-1.37)
Dinfra*LUE(t)				-0.0306	-0.0312
				(-0.65)	(-0.66)
Dinfra*LUE(t-1)				0.0161	0.0127
				(0.49)	(0.34)
Dinfra*LUE(t-2)				-0.0334	-0.0346
				(-1.00)	(-1.03)
e(t-1)	-0.0823	-	-0.0826	-0.0810	-0.0701
	(-3.28)		(-3.38)	(-3.27)	(-2.32)
e*HUE(t-1)	-	-	-	-	-0.0456
					(-0.74)
e*LUE(t-1)				-	0.0166
					(0.15)
Constant	0.0126	0.0136	0.0125	0.0123	0.0125
	(8.69)	(9.56)	(8.70)	(8.40)	(8.35)
R^2	0.3214	0.3380	0.3632	0.3740	0.3754
n	308	308	308	308	308
k	3	5	6	12	14
F-value:					
C4 vs C3	-	-	-	0.85	-
C5 vs C4	-	-	-	-	0.33
F-value:					
Short run effect	-	-	6.59	2.75	2.30
Long run effect	-	-	11.91	2.42	1.95

Note: t-value within parenthesis. Parameters concerning fixed effects are not shown in the table, but available upon request. All short run effects are compared to model C1 and all long run effects are compared to model C2.

Table 5. Residential Construction, Housing Stock, State Intervention, and Economic Growth (Model A6 and A7).

	Model A6		Model A7	
	Coef.	t-value	Coef.	t-value
Dgdp(t-1)	.5256323	9.40	.5300731	9.21
Dgdp(t-2)	-.1428741	-2.43	-.1445125	-2.39
Dresi(t)	.0783915	4.99	.0427857	1.99
Dresi(t-1)	-.0297424	-1.78	-.0243667	-1.09
Dresi(t-2)	.009099	0.68	.0067801	0.33
Dresi*HUE(t)	.0207586	1.36	.0128593	0.80
Dresi*HUE(t-1)	.0243805	1.58	.0245987	1.51
Dresi*HUE(t-2)	.0128832	0.85	.0189599	1.18
Dresi*LUE(t)	.101891	3.43	.0878311	2.85
Dresi*LUE(t-1)	.0243439	0.78	.0165333	0.51
Dresi*LUE(t-2)	-.0042961	-0.12	-.0006632	-0.02
Dresi*HS(t)	-.0381397	-2.18	-.0152776	-0.77
Dresi*HS(t-1)	-.0068302	-0.36	-.005467	-0.27
Dresi*HS(t-2)	-.0050007	-0.33	-.0039318	-0.21
Dresi*PR(t)			.0414938	1.51
Dresi*PR(t-1)			-.0095015	-0.33
Dresi*PR(t-2)			.0123158	0.52
Dresi*OW(t)			.0419695	2.18
Dresi*OW(t-1)			-.0088019	-0.41
Dresi*OW(t-2)			-.0017533	-0.09
e(t-1)	-.1979958	-4.17	-.1724856	-2.42
e*HUE(t-1)	-.0169672	-0.25	-.0231388	-0.34
e*LUE(t-1)	.026516	0.31	.0370442	0.43
e*HS(t-1)	.1708169	3.17	.1456686	2.56
e*PR(t-1)			.0376601	0.53
e*OW(t-1)			-.056066	-0.83
cons	.0132317	8.73	.0132069	8.61
R-sq	0.5024		0.5173	
F-value				
A6 vs A5	3.80			
A7 vs A5			1.99	
A7 vs A6			1.08	